NOTES

ON ANIMAL MECHANICS,

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No. VIII.—Further Comparison of the Hip Joint and Knee Joint Muscles in Cercopithecus, Cynocephalus, and Macacus.

Since publishing in Notes I. and II. my earlier observations on the muscular mechanism of the hip joint in Man and some of the lesser Monkeys, I have made further observations on this subject, a summary of which seems to me worthy of being laid before the Academy.

1. *Cercopithecus mona?* (male).

From the dissection of a specimen of a male *Cercopithecus mona* I obtained the following results:—

Muscle.	Actual Weight. Grs.	Percentage.	
1. Psoadiliacus,	385	9·5	
2. Adductores,	836	20·7	
3. Glutæus maximus,	209	5·1	
4. Glutæus medius,	407	10·1	
5. Glutæus minimus,	44	1·1	
			46·5
1. Biceps femoris,	561	13·9	
2. Semimembranosus, 3. Semitendinosus,	330	8·1	
4. Gracilis, 5. Sartorius,	198	4·9	
6. Quadriceps extensor femoris,	1080	26·6	
			53·5
Totals,	4050 grs	100·0	100·0

	Grs.
Weight of Monkey, ...	51,860
,, heart, ...	286
,, liver, ...	1650
,, brain, ...	946

	Percentage.
Proper muscles of hip joint, ...	46·5
Flexors of knee, ...	26·9
Extensors of knee, ...	26·6
	100·0

On projecting the planes of motion of the hip joint muscles on the plane of the rim of the acetabulum, I obtained the following results :—measuring the azimuths of the moments from the plane of motion of the knee joint, which is the natural zero plane for the hip joint—

Muscle.	Azimuth.	Moment.
1. Psoadiliacus, ...	20°	9·5
2. Adductores, ...	139	20·7
3. Glutæus maximus, ...	326	5·1
4. ,, medius, ...	341	10·1
5. ,, minimus, ...	351	1·1

If we refer these moments to the plane of motion of the knee joint, which is the plane of Flexion and Extension of the thigh upon the body, and to the plane of Adduction and Abduction, perpendicular to the former plane, we can readily construct the following Table of Component Moments :—

Component Moments of Hip Joint Muscles of Cercopithecus mona.

Muscle.	Flexion.	Extension.	Adduction.	Abduction.
1. Psoadiliacus, ...	8·93	. .	3·25	. .
2. Adductores, ...	. .	15·62	13·58	. .
3. Glutæus maximus, ...	4·23	. .	. .	2·85
4. ,, medius, ...	9·55	. .	. .	3·29
5. ,, minimus, ...	1·08	. .	. .	0·17
Totals, . .	23·79	15·62	16·83	6·31

Subtracting the moments acting in opposite directions, we find—

	Percentage.
Total flexion, ...	8·17
Total adduction, ...	10·52

2. *Cercopithecus callitrichus?* (male).

From a fine specimen of this Monkey I obtained the following results :—

Muscle.	Actual Weight. Grs.	Percentage.	
1. Psoadiliacus,	360	8·0	
2. Pectinæus,	88	1·9	
3. Obturator externus,	77	1·7	
4. Adductores,	710	15·4	
5. Quadratus femoris,	66	1·4	
6. Obturator internus,	100	2·2	
7. Glutæus maximus,	192	4·2	
8. ,, medius,	490	10·6	
9. ,, minimus,	60	1·3	
			46·7
1. Biceps femoris,	649	14·1	
2. Semimembranosus,	297	6·4	
3. Semitendinosus,	176	3·8	
4. Gracilis,	198	4·3	
5. Sartorius,	33	0·7	
6. Quadriceps extensor femoris,	1111	24·0	
			53·3
Totals,	4607 grs.		100·0

	Percentage.
1. Proper muscles of hip joint,	46·7
2. Flexors of knee,	29·3
3. Extensors of knee,	24·0
	100·0

Referring the moments of the hip joint muscles to the plane of the brim of the acetabulum, I found—

Muscle.	Azimuth. Degs.	Moment. Percentage.
1. Psoadiliacus,	20	8·0
2. Pectinæus,	94	1·9
3. Adductores,	137	15·4
4. Obturator externus,	149	1·7
5. Quadratus femoris,	180	1·4
6. Obturatur internus,	230	2·2
7. Glutæus maximus,	326	4·2
8. ,, medius,	341	10·6
9. ,, minimus,	351	1·3
		46·7

If these moments be resolved, as before, along the directions of

Flexion and Extension of the knee joint, and of abduction and adduction perpendicular to it, we find—

Muscle.	Flexion.	Extension.	Adduction.	Abduction.
1. Psoadiliacus, ...	7·52	. .	2·73	—
2. Pectinæus, ...	. .	0·13	1·89	—
3. Adductores, ...	. .	11·24	10·50	—
4. Obturator externus, . .	. .	1·46	0·87	—
5. Quadratus femoris, . .	. .	1·40	. .	—
6. Obturator internus, . .	. .	1·41	. .	1·68
7. Glutæus maximus, . .	3·48	. .	. .	2·35
8. ,, medius, ...	10·02	. .	. .	3·45
9. ,, minimus, ...	1·28	. .	. .	0·20
Totals, ...	22·30	15·64	15·99	7·68

Subtracting opposite moments, we find—

	Percentage.
1. Total flexion, ...	6·66
2. Total adduction, ...	8·31

3. *Cynocephalus porcarius* (Chaema).

From a specimen of this Cynocephalus, I obtained the following results and measurements :—

Muscle.	Actual Weight. Ozs. Av.	Percentage.	
1. Psoadiliacus, ...	0·35	3·1	
2. Pectinæus et Adductor brevis, .	0·17	1·5	
3. Obturator externus, ...	0·27	2·4	
4. Adductor magnus et longus, .	1·40	12·6	
5. Quadratus femoris, ...	0·14	1·3	
6. Obturator internus, ...	0·31	2·8	
7. Glutæus maximus, ...	0·57	5·1	
8. ,, medius, ...	1·27	12·3	
9. ,, minimus, ...	0·22	2·0	
			43·1
1. Biceps femoris, ...	1·40	12·6	
2. Semimembranosus, ...	0·95	8·5	
3. Semitendinosus, ...	0·48	4·2	
4. Gracilis, ...	0·51	4·5	
5. Sartorius, ...	0·28	2·6	
6. Rectus femoris, ...	0·63	5·6	
7. Vastus externus, ...	1·40	12·6	
8. ,, internus, ...	0·45	4·0	
9. Cruræus, ...	0·25	2·3	
			56·9
Totals, . . .	11·05 oz.		100·0

Proper muscles of hip joint, ...	43·1
Flexors of knee, ...	32·4
Extensors of knee, ...	24·5
	100·0

Referring the moments, as before, to the plane of the rim of the acetabulum, I found—

Muscle.	Azimuth. Degs.		Moment. Percentage.
1. Psoadiliacus, ...	28	. . . .	3·1
2. Pectinæus et adductor brevis, .	74	. . . . .	1·5
3. Adductor magnus et longus, .	137	. . . .	12·6
4. Obturator externus, ...	148	. . . .	2·4
5. Quadratus femoris, . . .	180	. . . .	1·3
6. Obturator internus et Gemelli,	226	. . . .	2·8
7. Glutæus maximus, &c., . . .	328	. . . .	5·1
8. ,, medius et pyr., . .	347	. . . .	12·3
9 ,, minimus, ...	355	. . . .	2·0
			43·1

Resolving these moments, as before, we obtain—

Muscle.	Flexion.	Extension.	Adduction.	Abduction.
1. Psoadiliacus, ...	2·74	. .	1·45	. .
2. Pectinæus et Ad. brevis,	0·41	. .	1·44	. .
3. Obturator externus, . .	. .	2·03	1·27	. .
4. Add. mag. et long., . .	. .	9·21	8·59	. .
5. Quadratus femoris, . .	. .	1 30	. .	. .
6. Obt. int. et Gemell., . .	. .	1·94	. .	2·01
7. Glut. max., &c., ...	4·33	. .	. .	2·70
8. ,, med. et pyriform.,	12·23	. .	. .	2·76
9. ,, minimus,.	1·99	. .	. .	0·17
Totals, ...	21·70	14·48	12·75	7·64

Subtracting opposite moments, we find—

	Percentage.
Total flexion, ...	7·22
Total adduction, ...	5·11

4. *Macacus nemestrinus.*

The following Tables are deduced from Note VII., on the Muscular Anatomy of the *Macacus nemestrinus* :—

Muscle.	Actual Weight. Ozs. Av.	Percentage.	
1. Psoadiliacus,	1·87	10·9	
2. Pectinæus,	0·22	1·3	
3. Adductor brevis,	0·37	2·1	
4. ,, magnus,	3·20	18·8	
5. Obturator externus,	0·53	3·1	
6. Adductor longus,	0·90	5·3	
7. Quadratus femoris,	0·46	2·7	
8. Obturator internus, &c.,	0·75	4·4	
9. Glutæus maximus, &c.,	0·90	5·2	
10. ,, medius, &c.,	1·95	11·4	
11. ,, minimus, &c.,	0·37	2·1	
			67·3
1. Biceps femoris,	1·10	6·8	
2. Semimembranosus,	0·67	3·9	
3. Semitendinosus,	0·61	3·5	
4. Gracilis,	0·55	3·2	
5. Sartorius,	0·32	1·8	
6. Rectus femoris,	0·80	4·7	
7. Vastus externus,	0·82	4·8	
8. ,, internus,	0·40	2·3	
9. Cruræus,	0·30	1·7	
			32·7
Totals,	17·09		100·0

	Percentage.
Proper muscles of hip joint,	67·3
Flexors of knee,	19·2
Extensors of knee,	13·5

Referring the moments of the hip joint muscles to the rim of the acetabulum, I found—

Muscle.	Azimuth. Degs.	Moment. Percentage.
1. Psoadiliacus,	26	10·9
2. Pectinæus,	55	1·3
3. Adductor brevis,	86	2·1
4. ,, magnus,	132	18·8
5. Obturator externus,	132	3·1
6. Adductor longus,	157	5·3
7. Quadratus femoris,	180	2·7
8. Obturator internus et Gemelli,	223	4·4
9. Glutæus maximus, &c.,	335	5·2
10. ,, medius, &c.,	348	11·4
11. ,, minimus,	356	2·1

Resolving these moments, as before, we obtain—

Muscle.	Flexion.	Extension.	Adduction.	Abduction.
1. Psoadiliacus,	9·77	..	4·78	..
2. Pectinæus,	0·74	..	1·06	..
3. Adductor brevis,	0·14	..	2·09	..
4. ,, magnus,	..	12·58	13·97	..
5. Obturator externus,	..	2·07	2·30	..
6. Adductor longus,	..	4·88	2·07	..
7. Quadratus femoris,	..	2·70	..	..
8. Obturator internus,	..	3·22	..	3·00
9. Glutæus maximus,	4·71	..	..	2·76
10. ,, medius,	11·15	..	..	2·37
11. ,, minimus,	2·09	..	..	0·14
Totals,	28·60	25·45	26·27	8·27

Subtracting the opposite moments, we find—

	Percentage.
Total flexion,	3·15
Total adduction,	18·00

If we collect together the preceding results into one Table, having first reduced them to percentages of the proper muscles of the hip joint, we shall obtain the following results, which represent the total flexion and adduction, expressed as percentages, compared with each other.

	Total Flexion.	Total Adduction.
1. Cercopithecus mona,	17·57	22·62
2. ,, callitrichus,	14·26	17·79
3. Cynocephalus porcarius,	16·75	11 85
4. Macacus nemestrinus	4·68	26·74

The relative proportions of the Glutæi muscles, in the smaller monkeys, I have found to be as follows:—

	Gl. max.	Gl. med.	Gl. min.
1. Cercopithecus mona,	31·6	61·6	6·8
2. ,, callitrichus,	25·9	66·0	8·1
3. Cynocephalus porcarius,	27·7	61·6	10·7
4. Macacus nemestrinus,	28·0	60·6	11·4
5. Lagothrix Humboldtii,	37·9	54·5	7·6